A Coordinated Framework for Soybean Rust Surveillance, Reporting, Prediction, and Management

March 12, 2004

In response to the recent introduction of soybean rust (SBR) *Phakospora pachyrhizi*, into the United States, USDA is facilitating the development of a federal/state/industry coordinated framework for surveillance, reporting, prediction, and management for the 2005 growing season. The cooperating USDA agencies include the Cooperative State Research Extension and Education Service (CSREES), the Agricultural Research Service (ARS), and the Animal Plant Health Inspection Service (APHIS). The plan will be announced at an USDA-APHIS-sponsored meeting with stakeholders from industry, federal, state and university on February 4th in Indianapolis, Indiana. The multi-agency group assigned to develop the plan includes: Roger Magarey , Coanne O'Hern, (USDA-APHIS); Rick Bennett, Richard Wilson, Doug Luster, Glenn Hartman, Monte Miles (USDA-ARS); Geir Friisoe (National Plant Board), Kitty Cardwell (USDA-CSREES), X.B. Yang (Iowa State University), Bill Dolezal (Pioneer), Scott Isard (Penn State University), Don Hershman (University of Kentucky), David Wright (NCSRP), Bev Paul (American Soybean Association) and Stephen Muench (United Soybean Board). The framework draws from ideas and material presented at the USDA-ARS Strategic Planning meeting held on December 1-2, 2004.

Deliverables

The goal of the framework is to provide stakeholders with effective decision support for managing soybean rust during the 2005 growing season. We intend to achieve this goal through the consensus-building and commitment of cooperating parties on our roles and responsibilities, and delivery of our respective contributions (i.e. disease observations, diagnostic results, decision support paradigms, models, etc.), through means that hold all parties accountable, and provide communication with stakeholders. The basic deliverables of the framework are outlined below:

1) Deliver a surveillance and monitoring network to provide timely information of the incidence and severity of soybean rust in the United States, Caribbean basin, and Central America.
2) Provide a web-based system (USDA Soybean Rust Monitoring and Prediction System) for information management of monitoring observations, forecasts, and decision criteria to stakeholders.
3) Develop decision criteria for fungicide application.
4) Provide predictive modeling of aerial transport of SBR spores from active source regions to soybean growing areas in the U.S.
5) Provide outreach for training, education, interpretation of web-based SBR monitoring and prediction displays, and dissemination of information.

APHIS has been identified as the lead agency on soybean rust in 2005, but a separate transition plan for future years involving state and industry contributions is under development.

Introduction

Soybean rust was introduced into the continental United States in the fall of 2004, presumably as a consequence of tropical storm activity. Model predictions indicated that soybean rust had been widely dispersed throughout the southeastern United States, and subsequent field and laboratory observations confirmed this distribution. The following figures 1 and 2 provide information on spore deposition in late 2004 and overwintering areas for soybean rust in the continental United States.

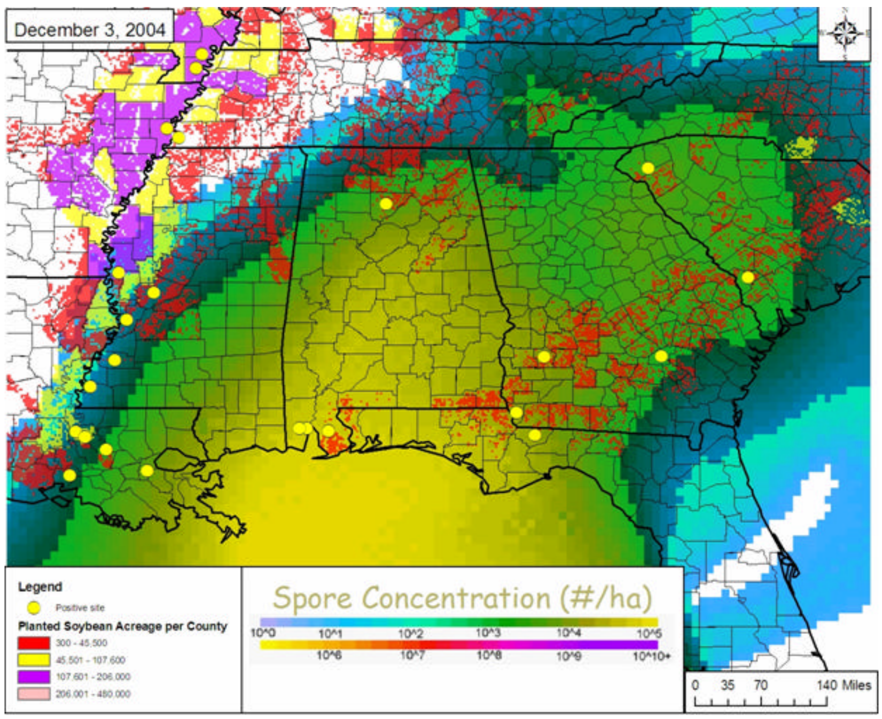

Figure 1. Estimated initial distribution of soybean rust, based on spore deposition and confirmed observations (yellow circles) as of December 1, 2004.

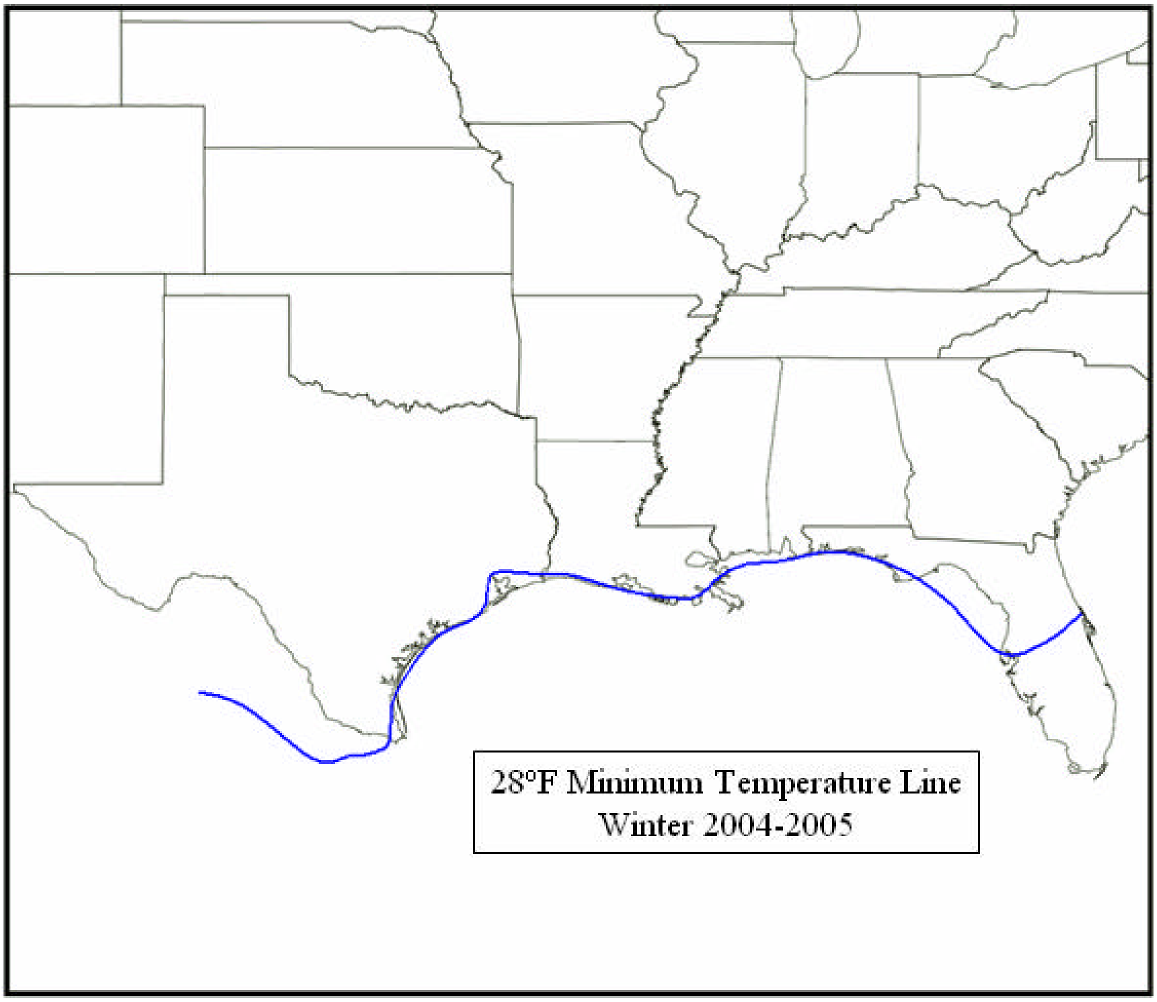

Figure 2. Estimated overwintering area for soybean rust based on the number of accumulated days with the minimum daily temperature less than 28 ºF as of January 28, 2005. Overwintering areas for hosts of soybean rust exist south of the 28ºF isopleth.

A comparison of predicted spore deposition (Figure 1) and overwintering areas (Figure 2) indicates rust survival will be limited, but present in the continental United States as of January, 28 2005. It is important to note that the predicted area of soybean rust deposition included the western Caribbean, south-eastern Mexico and Central America (Figure 3). **Soybean rust has not been confirmed in these regions and the potential for spore production is unknown. If present, the sub-tropical and tropical climates of these regions are likely to ensure year round survival of the pathogen.**

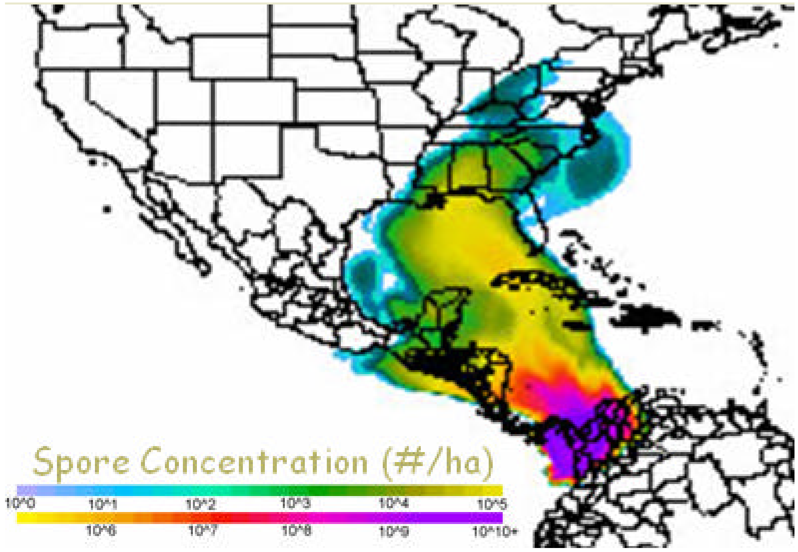

Figure 3 Estimated soybean rust spore deposition in the western Caribbean, south-eastern Mexico and Central America.

Experience with other aerially dispersed pathogens such as Tobacco Blue Mold, confirms the potential of the western Caribbean and Yucatan peninsula to act as overwintering source areas for the initiation of epidemics in the continental United States.

The current USDA efforts to monitor and predict the distribution of soybean rust follows previous APHIS efforts to prevent the introduction and establishment of exotic pests. In 2003, USDA CSREES set-up the National Plant Diagnostic Network (NPDN), which is a network of Land Grant University and State Department of Agriculture plant disease and pest diagnostic clinics from across the United States. The NPDN allows diagnosticians, State Regulatory personnel, and first detectors to efficiently communicate information, images, and methods of detection in a timely manner. The APHIS Cooperative Agricultural Pest Survey (CAPS) program conducts annual surveys for exotic pests with national, regional and state targets. The CAPS program has supported a number of novel techniques and methods for pest survey and detection. Beginning in 2002, APHIS in association with North Carolina State University, sponsored the development of the NCSU APHIS Plant Pest Forecast System (NAPPFAST). The NAPPFAST system uses biological models, climate and other GIS data layers to forecast pest occurrence. As part of this effort beginning in 2003, APHIS began the development of the Integrated Aerobiological Modeling System (IAMS), which was designed to track the aerial movement of invasive pests and focused on tracking the off-shore movement of soybean rust. Beginning in late 2004, following the first detection of soybean rust in the continental United States, the IAMS system was modified to create a specialized system focused solely on soybean rust – the Soybean Rust Aerobiology Prediction System (SRAPS). The SRAPS was developed with additional funding from CSREES. These pest forecasting innovations laid the information technology foundation for the USDA framework.

The Soybean Rust Aerobiology Prediction System or SRAPS will provide information for locating strategic sites to monitor for soybean rust incidence and severity during spring and summer 2005. Climatologically-based assessments of the potential occurrence of *P. pachyrhizi* epidemics using three different soybean rust overwintering scenarios will be produced and provided to stakeholders on the project's website. Components of the analysis include: (i) source area delineation based on soybean crop and kudzu distributions, (ii) three temperature-based overwintering scenarios (warm, average, cool) for the Caribbean basin (including southern U.S.), (iii) NDVI-calibrated, temperature-driven greening function for North America, (iv) evaluation of spore aerial transport potential using 24 years of data (NWS Reanalysis 2 data set) including pressure, wind and temperature data fields with 6 hr resolution and corresponding cloud cover and precipitation records, (v) soybean crop growth model driven by daily temperature and precipitation data from past 5 years, and (vi) soybean rust epidemiology model driven by daily temperature and leaf wetness data from past 5 years. The assessment will describe the level of risk (low, medium, high) of SBR epidemics occurring in U.S. regions and will be delivered by early March 2005 on three maps, one for each overwintering scenario.

The five basic deliverables of the framework cover the important components of a properly coordinated response namely surveillance and monitoring, dissemination to stakeholders, decision criteria for management, disease prediction models and communication and Outreach. Each component includes general and specific protocol information and addresses questions of resource and personnel allocation.

1. Domestic and international SBR surveillance and monitoring system

The following describes a framework for a coordinated national monitoring system. The monitoring program will be a cooperative effort between State Departments of Agriculture, Land Grant Universities, industry, the National Plant Diagnostic Network and the USDA. The objective of this section is to build a framework upon which these individual monitoring efforts can be coordinated. As a part of this effort all soybean production states were requested to provide information about their proposed soybean rust monitoring efforts in 2005. Many states are in an advanced state of readiness, while other states are seeking guidance and/or funding (Appendix 1). At the time of this document's compilation it had not been possible to receive feedback from all the states mentioned in this document.

This framework provides suggested protocols for the monitoring effort including resource allocation, data collection and data communication. It is important to note the suggested distribution of resources is subject to negotiation and also represents a minimum, leaving states free to deploy additional resources at their own discretion.

The monitoring program includes six components:

i) A fixed-site sentinel program to estimate spore production in overwintering and growing season source areas;

ii) A mobile survey to confirm new source areas and to calibrate spore deposition from the soybean rust prediction model;

iii) Industry surveys provide confirmation of rust in additional locations;
iv) Passive surveillance through public and private sample submission to the National Plant Diagnostic Network (NPDN); and
v) International monitoring to determine the importance of off-shore source areas.
vi) Spore sampling in rain to provide early warning and to assist with model calibration of predicted spore deposition concentrations.

i) Sentinel network

Sentinel plots are being funded by the USDA and the North Central Soybean Research Program (NCSRP). The USDA program covers 30 states and the NCRSP program 20 states (Table 1). In some states there maybe a separate lead for NCSRP and USADA sentinel plots, in other states there may be a single leader. . One protocol has been developed for both NCSRP and USDA plots and data from both programs will be uploaded to the USDA web site. There are three functions of the sentinel program. One function of the sentinel network is to quantify the timing of spore production in overwintering and growing season source areas. Spore production in source regions is an important input for the soybean rust aerobiology prediction system. A second function is to serve as a warning network for new disease observations in the soybean production regions. Consequently, Southern and Mississippi Valley states have a higher density of plots relative to their soybean production acreages. A third function of the sentinel plot system is to provide a means to collect data for epidemiological research. The epidemiological research plots use the plant based protocol shown below. If possible, the epidemiological research plots should not be destroyed and observations should continue beyond first detection. We would like some plots in each state to be epidemiological research plots.

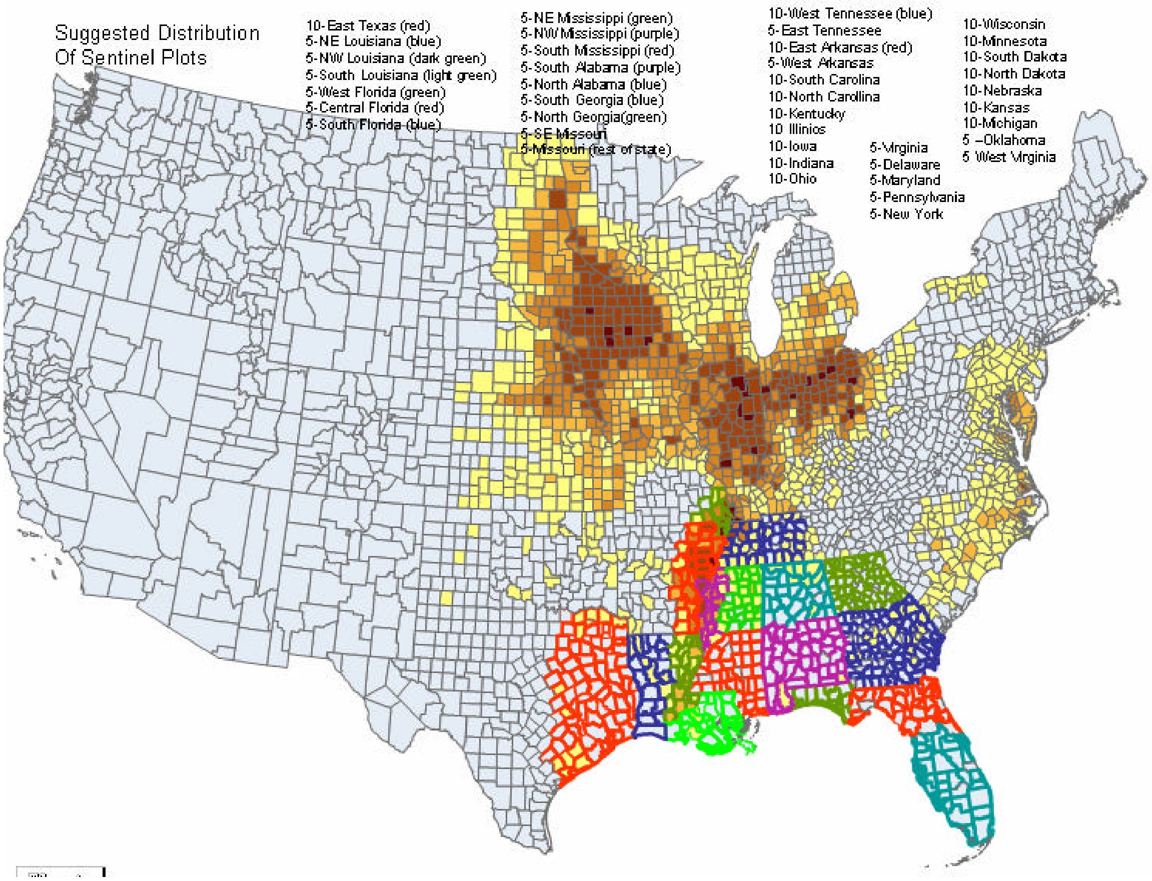

Figure 4 Distribution of sentinel plots and soybean production (NAS, 2002)

Table 1. State soybean production, kudzu distribution and proposed minimum distribution of sentinel plots.

State	Soybean Acreage 2004[a]	Average Planting Date[b]	Kudzu Acreage[c]	USDA Sentinels	NCRSP Sentinels
Alabama	190	May 25 to June 25	117510	10	20
Arkansas	3150	May 25 to June 20	10091	15	20
Delaware	208	May 28 to June 26	1	5	
Florida	17	May 15 to June 15	12449	15	20
Georgia	270	May 27 to June 27	151318	10	20
Illinois	9900	May 15 to June 9	529	10	20
Indiana	5520	May 15 to June 5	98	10	20
Iowa	10150	May 14 to June 2		10	20
Kansas	2710	May 25 to June 20	6	10	20
Kentucky	1300	May 25 to June 25	18051	10	20
Louisiana	990	May 15 to June 15	4824	15	20
Maryland	495	May 28 to June 26	134	5	
Michigan	1980	May 18 to June 3		10	20
Minnesota	7050	May 16 to June 3		10	20
Mississippi	1640	April 25 to May 25	250632	15	20
Missouri	4960	May 25 to June 1	1166	10	20
Nebraska	4750	May 18 to June 4	51	10	20
New Jersey	103	June 14 to July 14	9	5	
New York	172	No data		5	
North Carolina	1500	May 20 to June 30	57660	10	
North Dakota	3570	May 19 to May 29		10	20
Ohio	4420	May 10 to June 7	58	10	20
Oklahoma	290	May 18 to June 22	31	5	
Pennsylvania	425	May 20 to June 10	1	5	
South Carolina	530	May 27 to June 27	73742	10	
South Dakota	4120	May 20 to June 6		10	20
Tennessee	1180	May 30 to June 25	64862	15	20
Texas	270	May 3 to June 14	50817	10	
Virginia	530	May 20 to June 30	11357	5	
West Virginia	18		1318	5	
Wisconsin	1550	May 15 to June 20		10	20
	73598		**826717**	**295**	
State	**Dry bean Production '000s acres**	**Average Planting date**		**Sentinels**	
Colorado	219			5	
Idaho	31			5	
Oregon				5	
Washington	20			5	
Total				**20**	
Grand Total				**315**	

[a] National Agricultural Statistics 2004.

[b] National Agricultural Statistics, 2002
[c] Data from Daryl Jewett, APHIS.
[d] States participating in Proposed North Central Soybean Research Fund project on monitoring (XB Yang and D Wright, Personal Communication).

Following the recent findings of the first report of soybean rust caused by *Phakopsora pachyrhizi* on dry beans in South Africa (Du Preez, 2005, Plant Disease Notes, APS) there has been an effort to add additional states to the program that have dry bean production. These states include Idaho, Washington, Oregon and Colorado. No additional details on monitoring programs in these states are available.

It is anticipated that one person could check 4-6 plots per day, depending upon travel time. Consequently, states with five plots might require 8 to 16 hours per week. States with 10 plots may require 16 to 24 hours per week. It is likely sentinel plots would need to be maintained over a 3 to 4 month period. Where possible sentinel plots should be maintained at an unsprayed site or at a grower site as an unsprayed strip should be left so that observations can continue. Leaving an unsprayed strip has been a practice widely used in Brazil. As well as allowing the monitoring program to continue, the strip often provides a visual reminder of the importance of fungicide application. The cost of the sentinel plot system has been estimated at $2,500 per plot per season. A total of 315 plots are recommended across the nation at a total cost of $787,500.

General Information

Surveys areas and/or plots should be:

- **Where practical existing production areas can be used rather than the expensive and labor intensive custom planting of plots**.
- Concentrated in areas south of the 28° F overwintering line or on legumes that survive winter.
- Sentinels plots may include pigeon pea, yam beans, kudzu and leguminous winter cover crops.
- Strategically placed near large reservoirs of overwintering inoculum that may be proximal to production areas
- Sentinel plots should be observed at least once per week. When model predictions or observations indicate rust appearance is imminent then observations should be every three days. Once rust has been detected in the plot, observations should be weekly.
- Early maturing varieties of soybean are the most preferred host for sentinel plots.
- A certain proportion of plots will be designated ‘epidemiological’ plots. The protocol for these plots will dictate more intensive disease observations than in the regular sentinel plots. The data from the epidemiological plots will also be used to drive the decision support system for farmers.
- The first positive or suspected positive in each sentinel plot should be confirmed by the diagnostic lab or USDA certified expert. New state confirmations should be confirmed by sending samples to the APHIS-PPQ National Identification

Services, but only through the State and/or Land Grant University (NPDN) lab as a first screen (see Federal/State Responsibility for Identification of *Phakopsora pachyrhizi*, USDA-APHIS-PPQ, December 6, 2004 (Appendix B or http://www.aphis.usda.gov/ppq/ep/soybean_rust/2-10policy.pdf).

For sentinel plots using soybean as the host:

- Plots should be approximately 2500 sq. feet (50 x 50 ft). Scout the central 30 x 30 ft area. Assess three different sites (stops) in each plot. The sites should be in a v-shape not a straight line.
- Use highly susceptible varieties
  - Maturity: mixture of early and late maturity
  - Mix planting: 4-row per variety with no spacing between varieties.
- For frost control in northern areas on early planted varieties, it is recommended to plant twice if the plot is not covered with sheeting. Use insecticides to control bean leaf beetle where appropriate.
- For a normal sentinel plot, a row-based evaluation should be made with disease severity observations made in the crop at three heights (low, middle and high).
- Another option is to collect a more intensive data set that can be used for epidemiological research. The research protocol assesses rust severity at three sites per plot and five plants per site. Disease severity is rated on each node beginning on the lowest attached leaf and ending with the first fully expanded leaf.
- Supporting plot data needs only to be entered once by the scout. Information needed is: GPS location, cultivar description/name, planting date, row spacing, planting density and field acreage.
- During each observation record the date, plant height, degree of canopy closure, and the vegetative and reproductive growth stages.
- Disease severity should be assessed using the following categories. Absent, low, medium, high. (Photographic definitions to be supplied).

For sentinel plots using non-soybean hosts:

- Plots should be approximately 2500 sq feet (50 x 50 ft), assess three sites per plot. At each site assess five plants or make a "row" assessment.
- Supporting plot data need only be entered once and should include the host name, host density, land use type, and the land unit acreage.
- Record for each inspection visit: date, disease severity, lesion type and sporulation (Y/N).
- Disease severity should be assessed at the three sites in the plot using the following categories. Absent, low, medium, high. Photographic definitions of severity classes will be available form the USDA web site.

Data uploading

There are three options for data uploading to USDA Soybean Rust Monitoring and Prediction System.

1) Paper form: The data can be entered manually on the USDA SBR web site using the on-line forms.
2) PDA device: USDA is in the process of developing some proprietary PDA software through North Carolina State University and the information technology company ZedX, Inc. The PDA software will be available for free download from the USDA web site. The PDA software will include forms for data entry as described by the three protocols in the framework. The PDA software includes the capability for uploading of both data and pictures.
3) File transfer. The data can be sent to USDA in Comma Separated Value (CSV) or MS Excel formats. A template will be available for downloading from the web site. The format for the data should be observer id#, date, latitude (decimal degrees), longitude (decimal degrees), presence (0 = absent, 1 = present) and PCR confirmation (0 = no, 1 = 20).

ii) Mobile field monitoring teams

Mobile teams calibrate predicted spore deposition and infection as estimated by an aerobiological model with observed disease incidence. This calibration enables model output to be used with greater confidence by stakeholders. Observations are used to define new source areas for begin each day's model forecast run.

General information

It is suggested that at least six mobile teams should be deployed at an estimated cost of $180,000. The cost of maintaining a mobile team is estimated at $30,000 per team per season. The location of the teams is shown in the action and time line section of this document (Table 2).

Table 2. Breakdown of regions for soybean rust mobile monitoring.

Region	States	Proposed Regional Coordinator(s)	Possible Location of mobile team
1. Delta/ Southern Plains	LA, MS, AR, TX, OK, TN, KY	John Rupe, AR Don Hershman, KY	LA
2. South Eastern	FL, GA, SC, AL, NC, VA	Ed Sikora, AL Don Hershman, KY	GA?
3. Corn Belt	IA, IL,IN, OH, MO, KS	X.B Yang, IA Dean Malvick, IL	IL
4. North East	PA, NY, MD, DE, WV, NJ	Eric De Wolf, PA	?

5. Great Lakes / Northern plains	NE, SD, ND, WI, MI, MN	Loren Giesler, Craig Grau, WI	IA or NE
Total	30		

- Deployment refers to the period of time when a mobile team is active and will respond with a field survey.
- Mobile teams are deployed beginning with the first soybean emergence in their state or region. Their deployment ends once the pattern of initial spore deposition and infection incidence has been established.
- Either soybean or alternative hosts may be used for the mobile survey.
- The disease forecast models will be available on the web and will include models provided by USDA, Iowa State University and NCSU University. The USDA model will predict spore deposition ranging from light to heavy on a logarithmic scale. In the days following deposition the model will track infection severity based on weather-driven epidemiological model (see prediction section for more details).
- The survey team should be deployed following the first instances or general patterns of predicted spore deposition in their region or state. The team leader should compile a weekly or daily log of predicted spore depositions and predicted infection severity in their region or state.
- Mobile teams must seek diagnostic confirmation of positive observations if soybean rust has not had laboratory confirmation in that state. New state confirmations should be confirmed by sending samples to the APHIS-PPQ National Identification Services, but only through the State and/or Land Grant University (NPDN) lab as a first screen (see Federal/State Responsibility for Identification of Phakopsora pachyrhizi, USDA-APHIS-PPQ, December 6, 2004 (Appendix B or http://www.aphis.usda.gov/ppq/ep/soybean_rust/2-10policy.pdf). Ongoing laboratory diagnosis can be provided by state and/or Land Grant University National Plant Diagnostic Network (NPDN) labs.

Specific information:

- Plots should be approximately 2500 sq. feet (50 x 50 ft). Assess three different sites (stops) in each plot. The sites should be in a v-shape not a straight line.
- Mobile surveys should transect the prediction spore deposition and infection severity plume. Replicated plots should be assigned to different spore deposition classes including zero.
- For a normal mobile survey, a row-based evaluation should be made with disease severity observations made in the crop at three heights (low, middle and high).
- Another option is to collect a more intensive data set that can be used for scientific research. The research protocol assesses rust severity at three sites per plot and five plants per site. Disease severity is rated on each node beginning on the lowest attached leaf and ending with the youngest fully expanded leaf.

- Predicted spore depositions and infection should be checked approximately 9, 12, 15 and 18 days after deposition or at the discretion of the state leader.
- Supporting plot data needs only to be entered once by the scout. Information needed is: GPS location, cultivar description/name, planting date, row spacing, planting density and field acreage.
- During each inspection visit record the date, plant height, degree of canopy closure, and the vegetative and reproductive growth stages.
- Disease severity should be assessed using the following categories. Absent, low, medium, high. Photographic definitions of severity classes to be supplied.

Data uploading

For mobile plots there are three options for data uploading to USDA Soybean Rust Monitoring and Prediction System.

1) Paper form: The data can then be entered manually on the USDA SBR web site using the on-line forms.
2) PDA device: USDA is in the process of developing some proprietary PDA software through North Carolina State University and the information technology company ZedX. The PDA software will be available for free download from the USDA web site. The PDA software will include forms for data entry as described by the three protocols in the framework. The PDA software includes the capability for uploading of both data and pictures.
3) File transfer. (For presence or absence data only). The data can be sent to USDA in Comma Separated Value CSV or MS Excel formats. The format for the data should be observer id#, date, latitude (decimal degrees), longitude (decimal degrees), presence (0 = absent, 1 = present) and PCR confirmation (0 = no, 1 = 20).

iii) Industry monitoring

Industry monitoring refers to survey data collected in commercial soybean production fields as part of commercial services, research or variety trials or extension programs that are conducted with an industry sponsor/partner. The data may be collected by extension agents, field agronomists, crop consultants or individual growers. The industry data provides additional confirmation of the spatial extent of disease spread as a supplement to other survey data.

General information:

- It is anticipated that the industry data will record the "presence or absence of SBR", although industry collaborators may also collect more detailed information if required.

- Estimation of the current distribution of cooperating industry scouts is provided below (Table 3).

- Data may be provided as unconfirmed field observations. The protocol for the dissemination of unconfirmed observations is discussed under the section "web dissemination."

- Industry monitoring data may be provided as a diagnostic sample through the National Plant Diagnostic Network (NPDN).

- New state confirmations should be confirmed by sending samples to the APHIS-PPQ National Identification Services, but only through the State and/or Land Grant University (NPDN) lab as a first screen (see Federal/State Responsibility for Identification of Phakopsora pachyrhizi, USDA-APHIS-PPQ, December 6, 2004; updated and posted to the APHIS-PPQ website February 10, 2005). Ongoing laboratory diagnosis can be provided by state and/or Land Grant University National Plant Diagnostic Network (NPDN) labs.

Table 3. Description of industry cooperators prepared to provide soybean rust monitoring data.

Type	**Status**	**Number of Personnel (Southern)**	**Data collection & Upload**	**Lab diagnostic capability**
Agricultural companies				
Pioneer – Bill Dolezal	20	120 (10)	Standard PDA	20
Monsanto - Scott Stein	20		PDA	
BASF - Ted Bardinelli Brad Guice	20			
Delta and Pine – Dr Kelly Whiting	20	11 (11)	Paper/ web	No
Dow	TBA			
Syngenta – Marshall Beatty, Alison Tally	TBA			
Crop consultants				
NAICC – Alison Jones	TBA.			
ASAC	No response			
ASFMRA	No response			

Specific information:

For a diagnostic sample

- Required information is date, county, presence or absence.

For an incidence only survey

- Required information is observer, plot ID, and location.
- During each inspection visit record the date, plant height, degree of canopy closure, and the vegetative and reproductive growth stages.
- Incidence is simply recorded as present or absent.

For a severity based assessment

- Plots should be approximately 2500 sq. feet (50 x 50 ft). Assess three different sites (stops) in each plot. The sites should be in a v-shape not a straight line.
- Supporting plot data needs only to be entered once by the scout. Information needed is: GPS location, cultivar description/name, planting date, row spacing, planting density and field acreage.
- Observations should be made at an unsprayed plot or if that is not possible in an unsprayed strip.
- During each inspection visit record the date, plant height, degree of canopy closure, and the vegetative and reproductive growth stages.
- Assess three different sites (stops) at each location. A row-based evaluation should be made with disease severity observations made in the crop at three heights (low, middle and high). Alternatively an assessment can be made on five plants as described under the sentinel plot protocol.
- Disease severity should be assessed using the following categories. Absent, low, medium, high. Photographic definitions of severity classes to be supplied.

There are four options for data uploading to USDA Soybean Rust Monitoring and Prediction System.

1) <u>Laboratory sample</u> Through a State or National Plant Diagnostic Network (NPDN) laboratory sample. The NPDN will provide USDA with daily data feeds of date, county, presence or absence as an excel file or CSV format. Or through a state lab
2) <u>Paper form</u>: The data can then be entered manually on the USDA SBR web site using the on-line forms.
3) <u>PDA device</u>: USDA is in the process of developing some proprietary PDA software through North Carolina State University and the information technology company ZedX. The PDA software will be available for free download from the USDA web site. The PDA software will include forms for data entry as described by the three protocols in the framework. The PDA software includes the capability for uploading of both data and pictures.
4) <u>File transfer.</u> (For presence or absence data only). The data can be sent to USDA in Comma Separated Value CSV or MS Excel formats. The format for the data should be observer id#, date, latitude (decimal degrees), longitude

(decimal degrees), presence (0 = absent, 1 = present) and PCR confirmation (0 = no, 1 = 20).

iv) Passive surveillance through the National Plant Diagnostic Network(NPDN) monitoring

The CSREES NPDN is a collective of Land Grant University (LGU) plant disease and pest diagnostic facilities from across the United States. The network allows Land Grant University diagnosticians and faculty, State Regulatory personnel, and first detectors to efficiently communicate information, images, and methods of detection throughout the system in a timely manner. Regional Centers are located at Cornell University (Northeast region), Michigan State University (North Central region), Kansas State University (Great Plains region), University of Florida at Gainesville (Southern region), and University of California at Davis (Western region). The National Agricultural Pest Information System (NAPIS) located at Purdue University has been designated as the central repository for archiving select data collected from the regions.

General information

- CSREES and its Land Grand University (LGU) partners, the NPDN and Cooperative Extension Services are preparing extension messages urging county extension agents, growers and private crop consultants to scout for SBR and to bring samples to the closest LGU diagnostic laboratory.
- In many soybean production states, growers have been trained to recognize suspected soybean rust symptoms and in diagnostic sample submission.
- Data from Soybean Rust samples will be uploaded to the centralized NAPIS database. The Plant Diagnostic Information System (PDIS) (www.pdis.org) will be used to alert producers and provide an access point for current incidence maps. The maps will be display presence or absence at county level and be updated on a daily basis. The incidence data will be uploaded daily to the USDA Soybean Rust Monitoring Web site.
- It has been estimated that the additional costs for diagnostic services for soybean rust in 2005 will be $45,000 per state or $1,170,000 for 26 states.

Protocol for sample submission

For cooperative extension agents, field scouts, crop consultants, or anyone conducting surveys of soybean rust on legume hosts, for sample submission to state or university diagnostic laboratories.

- Place leaf, stem, or pod samples in a self locking plastic bag and store under cool conditions.

- Record the collection information (date, exact location of the field and sample location within the field, county in which collected, host plant and collector's name and phone number) on a piece of paper included with the sample. If the collector has a copy of the PPQ form 391, the pertinent sections of that form should be completed and submitted with the specimen to the state or university diagnostic laboratory.

- Submit the sample through the appropriate State Department of Agriculture's diagnostic service or the land grant university's diagnostic laboratory in the state in which the sample was collected. Do not send suspect samples directly to the USDA Beltsville laboratory.

- A list of university diagnostic laboratories is available at the American Phytopathological Societies directory website: http://www.apsnet.org/directories/univ_diagnosticians.asp

- State Department's of Agriculture contacts are available at the National Plant Board website: http://www.aphis.usda.gov/npb/npbmemb.html.

- A 48-hour turnaround time is anticipated for soybean rust samples.

- Samples submitted to the NPDN diagnostic clinics and a positive or negative diagnosis will be entered (to the county level for willing participants only) and uploaded via the NPDN communications systems every 24 hrs to a data repository in the National Agriculture Pest Information System.

v) International monitoring

International monitoring efforts are being coordinated by Doug Luster, ARS. The focus of international monitoring will be on Mexico and the Caribbean, with particular emphasis on regions which may provide a source of wind-blown rust spores early in the Northern Hemisphere growing season that could impact the US on an annual recurring basis.

- The NPDN has established a state-equivalent plant diagnostic laboratory in the Southern Plant Diagnostic Network (SPDN) at the University of Puerto Rico, Juana Diaz, PR.

- Locations in the Caribbean (Dominican Republic, St. Thomas) and Mexico (Yucatan peninsula) will be surveyed for rust by Dr. Jose Hernandez, USDA ARS Systematic Botany and Mycology Laboratory, Beltsville, MD. No plans are yet in place to include Cuban agricultural scientists in monitoring rust outbreaks.

- Pioneer also has diagnostic capability in Salinas, Puerto Rico Diagnostic Laboratory is Isabel Marrero (isabel.marrero@pioneer.com). The laboratory has digital diagnostic linkage with our Johnston, IA laboratory. IN addition Pioneer maintains a laboratory in Puerto Vallerta which will monitor for soybean rust. Pioneer also maintains staff throughout Mexico which may contribute to a limited passive surveillance program.

vi) Spore sampling in rain

A sixth component of monitoring will be spore sampling in rain to assist in early detection and model calibration by determining observed spore deposition concentrations and timing prior to symptom development in the field. Most likely the movement of *Phakopsora pachyrhizi* (SBR) urediniospores from the southern plains will follow the same route as wheat rust urediniospores. Wheat stem rust fungus (*Puccinia graminis*) over winters along the Gulf Coast on fall planted winter and volunteer wheat, generally below latitude 30^{o} N. Disease in this area serves as inoculum for winter wheat planted in southern and central U.S and spring wheat in the northern plains. Urediniospores move northward as prevailing air movement is from south-to-north during the growing season, especially in the Great Plains. From south to north, the time of first observed disease in this "Puccinia Pathway" spans from late April (Texas) to early July (North Dakota).

Movement of rust spores along the "Puccinia pathway" has been studied using several different methods including trap plots and spore collectors. Examination of rain samples was shown to be the most reliable method for predicting first wheat stem rust infections dates in the Northern Plains. Real-time PCR methodology now allows for rapid and more precise identification of plant pathogens. A PCR assay has been developed by Dr Les Szabo (USDA ARS Cereal Disease Lab and University of Minnesota) to detect wheat stem rust urediniospores in rain samples. The lower limit of the current assay is about 10 spores per half-filter sample. The PCR method developed for *Puccinia* will now be adapted for soybean rust. It is proposed to develop a national sampling program using 124 National Atmospheric Deposition Program sites (Figure 5). Samples will be collected weekly and mailed to a central processing lab (NADP, Illinois State Water Survey) where they will be filtered. Filters will be sent to Dr. Szabo's lab for analysis on a weekly basis.

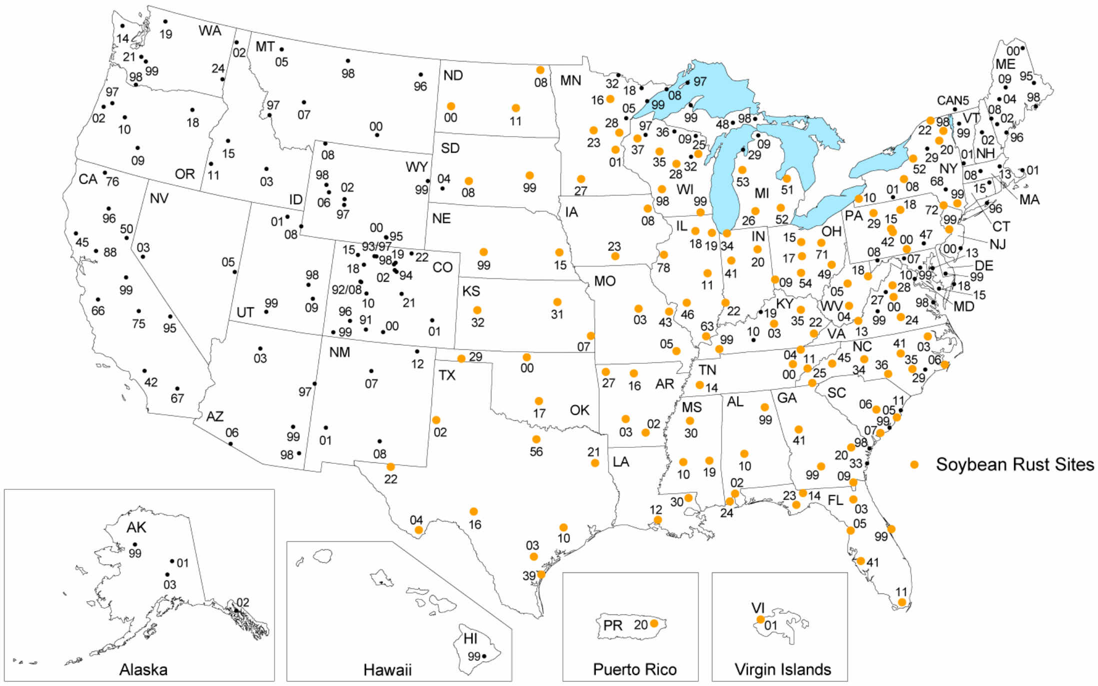

Figure 5. National Atmospheric Deposition Program collection sites for soybean rust (http://nadp.sws.uiuc.edu/).

The cost of the national sampling program is expected to be about $300,000. Considerable progress has been made by Dr Szabo in securing funding and developing the sampling and analytical protocols to make the program successful. The spore deposition data collected by the program will be relayed by file transfer protocol to the Soybean Rust Monitoring and Prediction System where the results will be displayed as weekly maps.

2. Information management of decision criteria, observations of soybean rust, and predictive model output to stakeholders. (USDA Soybean Rust Monitoring and Prediction System)

A web site will be created to disseminate information to stakeholders (Figure 6). The site's address is www.usda.gov/soybeanrust

- The USDA site (Soybean Rust Monitoring and Prediction System) is a collaborative project between Penn State University, North Carolina State University and the information technology company ZedX, Inc.
- The USDA web site is comprised of separate public, specialist, researcher and observer views.
- The web-site will feature a user interface which is zoomable from the national to the sub-county scale. The user interface includes a public site and password protected sites for research and data uploading.
- A calendar will allow a user to see the progression of disease severity and crop phenology on a day by day basis and will allow the user to move forward or backward in time.
- Observations will be displayed on the map using symbolic and color coding. Symbolic coding (e.g. +, o,□ ?) will distinguish observations from different protocols (e.g. sentinel, mobile, NPDN and industry). Color coding will be used to distinguish absent, present (unconfirmed), present (confirmed), pending and disease severity.
- Viewers from the public site see maps of management recommendations, observations and scouting at the county scale. Each of these maps is controlled at the county scale by the state specialist. Public viewers do NOT see model output but only state specialist's interpretation.
- The research and observer views will display observed and predicted disease severity and spore deposition. Predicted disease severity will be shown as a color scale from nil to severe based upon the proportion of diseased leaf area. Latent infections (those that have not yet appeared) will also be indicated on the color scale. The predicted and observed severity will use the same color coding scheme.
- Reference overlays include roads, crop commodities and county boundaries.
- Observers will be provided with user ID and password to USDA web site.
    - PDA users: PDA software is available for downloading from USDA web site. Upload data by synching PDA.
    - No PDA: Excel spreadsheets with data template can be downloaded from USDA website. Fill in excel spread sheet with observations and upload as CSV file. Alternatively web form can be filled out on-line.
- Interpretations of the public maps will be provided by an ARS national specialist. When a user clicks on an individual state, an interpretation from the state designated soybean specialist will also appear.

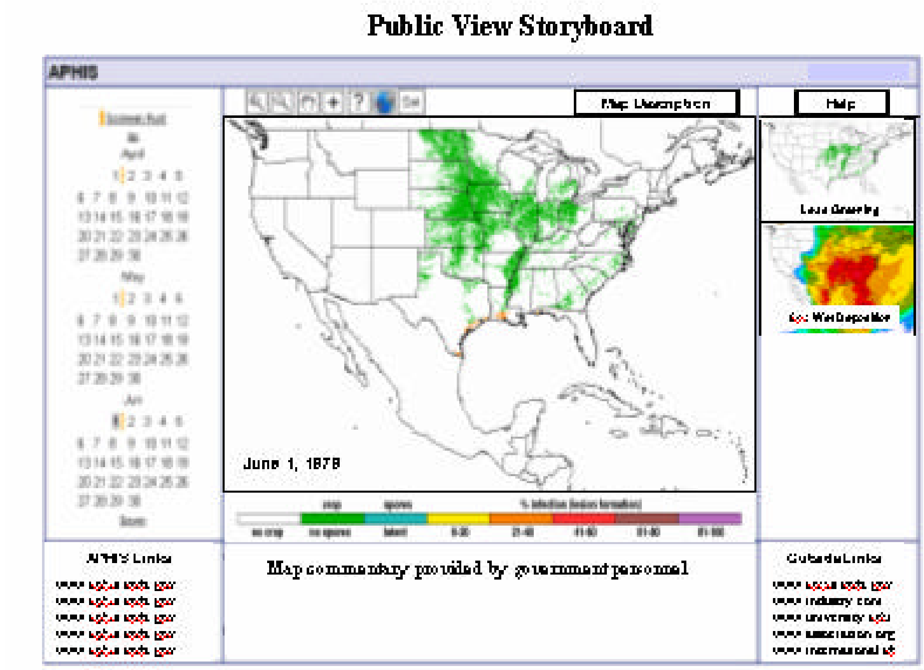

Figure 6. Storyboard design view of the USDA soybean rust web interface. The main features of the interface are a calendar, a zoomable map, report generation and a form for data entry.

- The web site will be linked from the USDA website. It is also hoped that the site will be linked from Land Grant University web pages and IPM centers.
- Full access to the research and data uploading sites will be given to USDA and university cooperators.

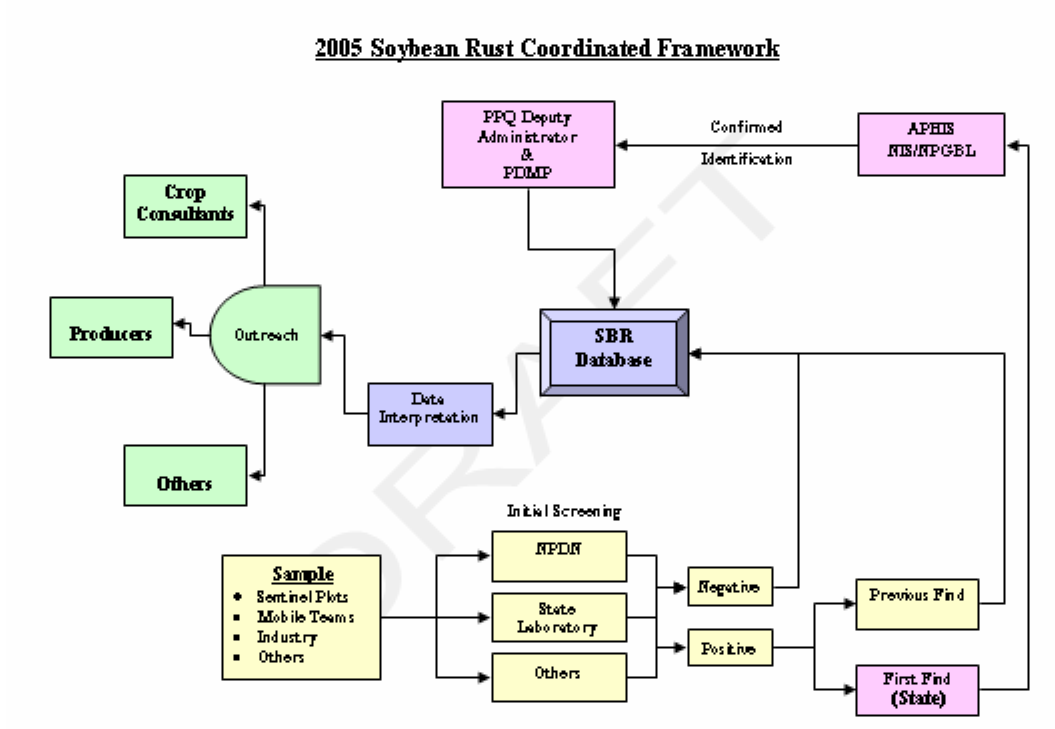

Figure 7. Information infrastructure for soybean rust from the perspective of sample submission and data flow.

- Information flow begins with sample submission and data collection (green shading), regulatory reporting (purple shading), information management including interpretation (blue shading) and ending with outreach (green shading) (Figure 7).

3. Decision criteria for fungicide application.

Fungicides will be the primary tools in the management of soybean rust in the United States. Guidelines for managing the disease are based on data from Africa and South America where it was found that the crop should be protected from the flowering stage through the grain fill stage. The most effective management programs were those that were preventative: that is, where the first application was applied before soybean rust was seen in the field. The efficacy of the products available in the U.S. (under either Section 3 or Section 18 registration) has been proven in trials in South America and Africa. The products that have proven efficacy include chlorothalonil, strobilurin and triazole products.

Each product has different strengths and weaknesses and they differ in how and when they should be used to manage soybean rust. None of the products can eradicate the fungus. The triazole products have curative activity (can inhibit but not eradicate existing infections) and are protectants while the chlorothalonil and strobilurin products only are protectants and only prevent new infections. The chlorothalonil and strobilurin products need to be applied before infection, and once the disease exceeds 1% incidence, yield losses may occur even with a subsequent application of a strobilurin product. Triazole products can be applied prior to or after the disease appears, but once the disease is at a 10% incidence or is in the mid-canopy, yield loss will be expected.

Monitoring will be critical in the decisions of when and what fungicides to apply. Predictive forecasting, although in its first year of validation and testing may also provide useful data for decision making. Based on experience in South America and South Africa, a typical management program may require two application of fungicides based on phenology of the plant at the reproductive growth stages. The first application is at growth stage R1-R2 and the second 14 to 20 days later. The program could also be based on a calendar with the first application at 50 days after planting and the second 14 to 20 days later. Monitoring data and predictive forecasts could be used to time fungicide applications, thus possible delaying the first application and/or eliminating the second.

Decision criteria are influenced by many factors

- Soybean rust is a rapidly spreading disease. Studies in Africa and South America have demonstrated that fungicides need to be applied before or as soon as the disease is detected in a production field.
- Late diagnosis of the disease could result in substantial crop loss. If heavy spore deposition occurs along with spore germination and colonization, it may be too late to effectively control the disease.
- Crop loss may occur if fungicides are applied late and few curative fungicides are available.
- The disease is difficult to observe and can be mistaken for other disorders or diseases.
- Soybean rust treatments should be applied at approximately 50 days after planting and 14 to 20 days later. An application should only be missed if disease was absent from the production area. If spore showers are likely then these treatments are essential regardless of whether disease has been yet observed in the actual farmer's field.
- By using ground-trusted prediction models there is potential to provide decision information to producers and other decision makers well before disease is observed in local fields and in time to apply timely and effective fungicide treatments.

Other comments

- To help evaluate the management program, growers should be encouraged to leave a strip unsprayed and mark it clearly.

- Risk communication efforts would be made before the 2005 growing season by land grant university extension to educate soybean producers on many issues including; i) the correct interpretation of monitoring data and predictive models; ii) the limitations and uncertainties associated with monitoring systems and predictive models; iii) decision criteria and risk management and iv) fungicide selection and timing.

4. Predictive models

- The Soybean Rust Aerobiology Prediction System (SRAPS) is collaborative project between Penn State University, North Carolina State University and the information technology company ZedX, Inc.
- The Soybean Rust Prediction System (SRPS) displays predicted rust severity at a 10 km^2 resolution across North America.
- The components of the (SRPS) model include: (i) source area delineation based on soybean crop and kudzu distributions, (ii) overwintering survival of rust in source areas, (iii) NDVI-calibrated, temperature-driven greening function for North America, (iv) evaluation of spore aerial transport potential using <insert data set> pressure, wind and temperature fields with 6 hr resolution and corresponding cloud cover and precipitation records, (v) soybean crop growth model driven by daily temperature and precipitation data from past 5 years, and (vi) soybean rust epidemiology model driven by daily temperature and leaf wetness data from past 5 years.
- Observations primarily from sentinel plots will be used to quantify the distribution of spore production in domestic and off-shore source regions.
- The system will display observed and predicted disease severity and spore deposition. Predicted disease severity will be shown as a color scale from nil to severe based upon the proportion of diseased leaf area. Predicted latent (infected but not yet appeared) will also be a severity class. The predicted and observed severity will use the same color coding scheme.
- The North American Disease Forecast Center (NCSU) will also provide disease forecasts using the HYSPLIT modeling system. The forecasts will be similar to those it has provided operationally for nine years. A link to these forecasts will be available from the web page. More information is included in the appendix.
- Iowa State University is also in the process of developing forecast models and will participate in the national forecasting efforts. Predicted daily weather data from an atmospheric model (MM5) will be used as inputs to make short term prediction of soybean rust risk in different geographic areas. A link to these forecasts will be available from the USDA web page. Information on these models will become available later.

5. Communication and Outreach

- The official USDA web-site development will be led by Kim Taylor, Director of the USDA Web services and Distribution section. Dr Taylor will design the site and linkages in consultation with other USDA personnel.
- The Southern Soybean Disease Working group, NC-504, NCDC-202, and NCR-137 will be meeting in Scottsdale, Arizona on March 2nd and 3rd.
- The American Phytopathological Society will organize a symposium to be held in late fall to discuss soybean rust and the lessons learnt in season 2005. APS will also facilitate real time publishing of fungicide efficacy studies
- The Plant Management Network will create a front page on Soybean Rust. Designed to provide plant science practitioners fast electronic access to proven solutions, the Plant Management Network offers an extensive searchable database comprised of thousands of web-based resource pages from the network's partner universities, companies, and associations. http://www.plantmanagementnetwork.org
- The University of Kentucky has created a List Serve to facilitate communication. For more details on the list serve please contact Don Herschman at (dherschman@uky.edu)
- Nebraska is establishing a Soybean Rust Hotline for its stakeholders. For more details contact Loren Giesler, University of Nebraska, lgiesler@unl.edu
- A group was designated to work with the American Certified Crop Advisors to facilitate outreach Bill Hoffman – CSREES, Steve Cain, Anne Dorrance, Loren Giesler, Mike Brown, Bob Ehart and X.B. Yang

5. Funding and transition plans

The cost of the USDA framework includes outreach, monitoring, information management, predictive modeling, and developing decision criteria for fungicide applications. Outreach includes state extension, regional and national efforts. The USDA is currently evaluating funding needs and opportunities to cost-share.

In subsequent years the cost of the monitoring program can be reduced since experience with the disease will be gained. In addition, fewer monitoring observations will be needed as input to the predictive model. It is anticipated in season 2006, that the monitoring could be cut in half. By season 2007, a quarter of the original number of monitoring sites might be needed and these might realistically be provided by industry and university cooperators.

6. Action and time line

Overall Coordination of Framework

A proposed soybean rust information architecture is shown below (Figure 8). The structure begins at the top with a steering committee comprised of the major soybean stakeholders. Three SBR National Framework Coordinators (SBR-NFC) each represent a USDA agency and report at weekly or bimonthly intervals to the steering committee.

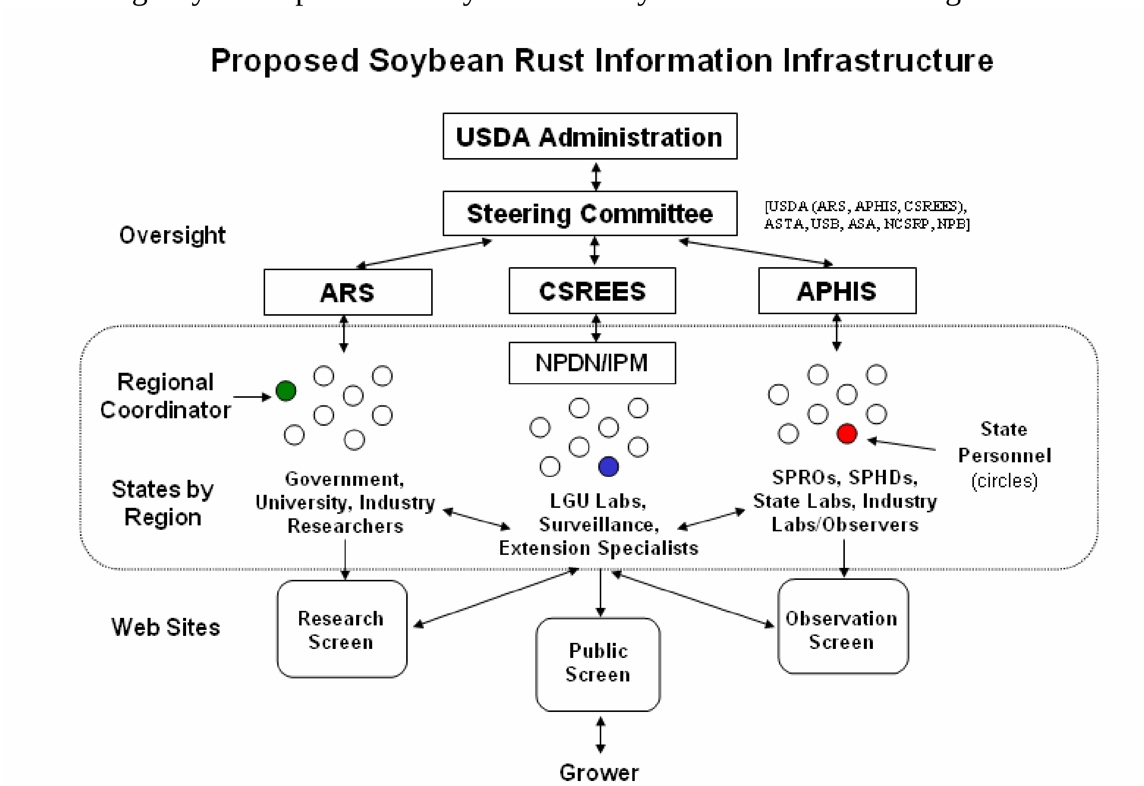

Figure 8. Proposed soybean information infrastructure from an organizational perspective.

The ARS SBR-NFC coordinates the activities of government, university and industry researchers related to decision criteria, prediction modeling and surveillance. The CSREES SBR-NFC coordinates the NPDN (National Plant Diagnostic Network) and outreach and evaluation through Integrated Pest Management Centers and through Land Grant University Extension services. The APHIS SBR-NFC coordinates the information management and surveillance systems through APHIS regional and state personnel and cooperators. Underneath the National coordinators is a network of Regional Framework Coordinators (SBR-RFC). The SBR-RFCs report to their respective SBR-NFC with weekly or bi-monthly phone conferences. A suggested regional structure is the USDA-ERS regions (Figure 9), although this is at the discretion of the NFCs. Below the regional coordinators are state coordinators who coordinate the relevant SBR framework activities in their state. State coordinators report to their respective SBR-RFC with weekly or bi-monthly phone conferences. Regional and State coordinators may serve in multiple capacities. For example a single individual may report to both ARS and APHIS SBR-NFCs.

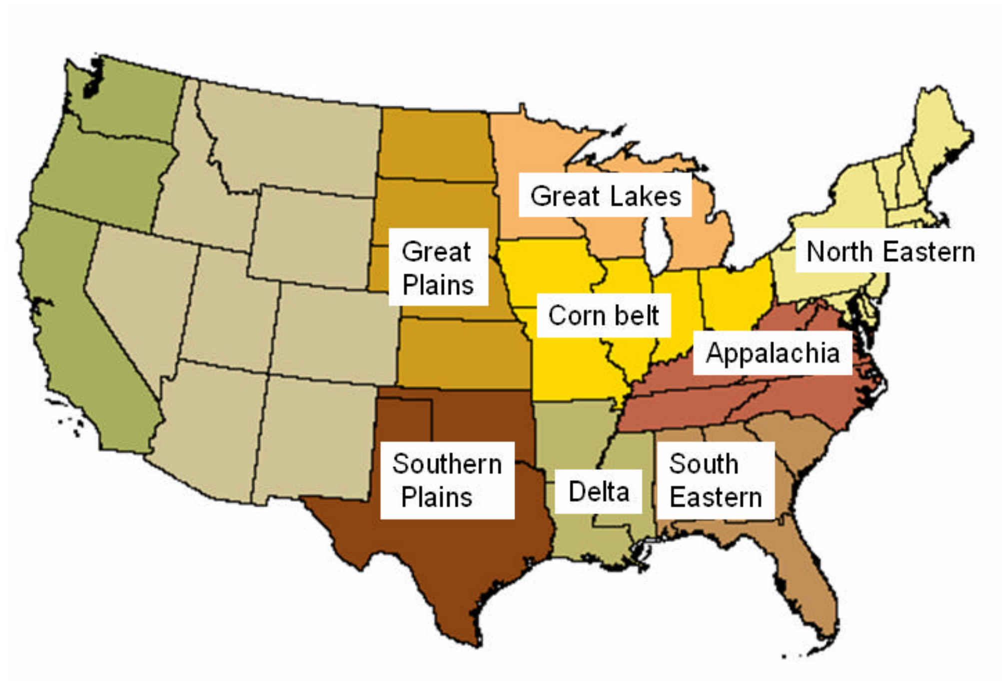

Figure 9. USDA-ERS regions.

Below the level of the state coordinators is the web interface. Individual users who are members of the three framework coordination groups can log –in and see a full set of model output, interpretations and observations on the research and observation web-site. Users in these groups can also upload or download observations. Pre-selected individuals in the ARS NFC group provide map interpretation which is refined for the public consumption by other users in the CSREES NFC group. The general public, including growers are restricted to the view from the public site which is limited to confirmed and pending observations, simplified model output (e.g. warning, watch and wait coding) and map interpretations.

Steering Committee

- The Steering Committee shall guide and evaluate progress in meeting the Framework objectives (monitoring, information management, predictive modeling, outreach, and decision criteria for using fungicides.), and will provide feedback to the coordinator responsible for their respective objectives.
- The Steering Committee shall include representatives from APHIS, CSREES, ARS, NPB, USB, ASA, ASTA, and NCSRP. (In other words the current Framework working group)
- The Steering Committee will hold weekly phone conferences to get updates.
- There shall be three reports to the steering committee from the National coordinators for i) ARS, ii) CSREES, and (including data uploading and downloading issues); iii) APHIS.

Duties of ARS NFC The ARS SBR-NFC coordinates the activities of government, university and industry researchers related to decision criteria, prediction modeling and surveillance. The proposed ARS SBR-NFC is Glenn Hartman, ARS.

- The national coordinator shall compile a list of soybean specialists coordinating information dissemination in each state. This list includes the NC-504 soybean rust group.
- Work with Anne Dorrance and NC-504 to coordinate documents related to fungicide application.
- Review monitoring observations and predictions weekly with regional coordinators.
- Supervise the dispatch of mobile teams.
- Supervise and coordinate the use and application of prediction models.
- The national coordinator shall write at least weekly interpretations of the soybean rust monitoring and prediction web site. Work with NC-504 to create a pre-season interpretation guide to assist stakeholders in use of the web site.
- Regional and state coordinator shall write additional interpretation messages for their regions and states as needed.
- Lead weekly or biweekly phone conferences with regional coordinators.

Duties of CSREES SBR-NFC. The CSREES SBR-NFC coordinates the NPDN (National Plant Diagnostic Network) and outreach and evaluation through Integrated Pest Management Centers and through Land Grant University Extension services. The proposed National Coordinator is Kitty Cardwell.

- Coordinate the SBR diagnostic activity of the NPDN.
- Oversee evaluation of user acceptance of Soybean Rust Monitoring and Prediction Web site. Bill Hoffman, Stuart Kuehn and Loren Giesler

volunteered for this task. (CSREES input needed). Create focus groups consisting of farmers, industry representatives, agronomists, and crop consultants etc to evaluate the Soybean Rust Monitoring and Prediction web site's ease of use. (CSREES input needed).

- Coordinate outreach and extension through IPM centers.
- Coordinate diagnostic workshops and training, fungicide application education, printing of a fungicide manual, reprints of the SBR ID card, training videos/DVD, reprinting the SBR Pest Alert, adequately supporting the NPDN infrastructure to assure surge capacity is accommodated (i.e. calc. 2000 samples to be processed by each lab in 26 States, within a two week period at peak season), in-field application technology education material, fungicide efficacy demonstration, and an epidemiological education resource guide needs to be developed and distributed.
- Bimonthly or weekly conference calls as needed with NPDN and IPM centers.

Duties of APHIS SBR-NFC coordinator. The coordinator will oversee the sentinel plots, mobile monitoring teams and industry monitoring. In addition the APHIS national coordinator shall supervise several components of information management. The proposed national coordinator is Coanne O'Hern.

- The national coordinator shall convene phone conferences with individual states to initiate the surveillance and information management program in each state.
- Create and implement a regional framework for surveillance and information management (Table 4).
- Allocate funding to support the national surveillance program.
- Assist the states to coordinate with industry and crop consultants to supply monitoring data.
- Create an informal manual describing the monitoring protocols including a list of the best non-soybean hosts.
- Assist regional coordinators in dealing with technical issues relating to data uploading from diverse sources.
- Lead weekly or biweekly phone conferences with regional coordinators.
- Supervise the development of the Soybean Rust Monitoring and Prediction web site, including the PDA tool, data uploading and technical support.
- Supervise the development of the USDA Soybean Rust Prediction model.

Table 4. Breakdown of regions for soybean rust monitoring and information management

Region	States	Proposed Regional Coordinator(s)
1. Delta/ Southern Plains	LA, MS, AR, TX, OK, TN, KY	John Rupe, AR Don Hershman, KY
2. South Eastern	FL, GA, SC, AL, NC, VA,	Ed Sikora, AL Don Hershman, KY
3. Corn Belt	IA, IL,IN, OH, MO, KS	X.B Yang, IA Dean Malvick, IL
4. North East	PA, NY, MD, DE, WV, NJ	Eric De Wolf, PA Gary Bergstrom, NY (tentatively)
5. Great Lakes / Northern plains	NE, SD, ND, WI, MI, MN, ON (Canada)	Loren Giesler, NE Craig Grau, WI
6. Western	CO, ID, OR, WA	TBA
7. Puerto Rico	PR	
Total	30	

Duties of APHIS technical Support Specialist
APHIS will provide a national technical support specialist (SRMP-TSS) for data uploading and downloading from the SRMP site. The specialist shall work with regional monitoring coordinators to address and communicate data uploading and down loading issues. The specialist shall report to the APHIS SBR-NFC

- Write a tutorial for use of SRMP web site.
- Coordinate with researchers who want to receive the monitoring data and use the research site.
- Test PDA software for industry, sentinel plots and mobile program.
- Develop a File Transfer Protocol for receiving CSV or Microsoft Excel files for industry, sentinel plots and mobile program.
- Develop a file transfer protocol so University and USDA researchers can download monitoring data.
- Develop a protocol for display of monitoring observations. This includes ensuring data is not reported twice and suspect data is eliminated or flagged as questionable.

Timeline

2004

September

- Soybean rust believed to have entered United States, possibly as a result of Hurricane Ivan or other tropical storms.

November

- Soybean Rust first identified in United States

December

- Working group begins to draft a Coordinated Framework for Soybean Rust.

2005

February

- Roll out of Coordinated Framework Document to stakeholders in Indianapolis.
- PDA program for industry protocol completed. First test of PDA program
- Soybean Rust Monitoring and Prediction System Public web site up and available and linked to USDA web site.
- National, regional, and state coordinators identified.
- Preseason climatological assessment of three scenarios using the Soybean Rust Aerobiology Prediction System available.

March

- USDA Soybean Rust Web Portal online.
- Refinement of monitoring plan at meeting of soybean researchers in Scottsdale, Arizona.
- PDA program for industry protocol released. Testing and release of program for mobile and sentinel plots protocols
- Soybean Rust Monitoring and Prediction Web Site active for data entry and PDA access. Interactive demonstration by Joe Russo in Riverdale (March 1).
- File transfer protocol available for users of industry protocol.
- State coordinators supply web links for state based information.
- Soybean Rust Aerobiology and Prediction system goes on-line with near real time and forecast data.
- Observations from NPDN available in map form and on-line.
- User evaluation of web site.
- NC 504 Guidelines fungicide Manual (pdf) linked to USDA web site.

- Pre-season interpretation guide written.

April

- SRMP web site tutorial available.
- Soybean Rust Monitoring and Prediction Web Site active for Research users. Observations from all collection protocols available in map form and on-line
- File transfer protocol available users of mobile and sentinel plots protocols.
- User evaluation of web site.
- Data transfer protocols available for monitoring data access by researchers.

May

- User evaluation of web site.
- Widespread planting and emergence of soybean in southern states.

June

- Widespread planting and emergence of soybean in northern states.

October onwards

- APS symposium on soybean rust to discuss lessons learnt.

6. Summary

- The five components of the plan are: 1) an operational surveillance and monitoring network; 2) a web-based system for information management; 3) decision criteria for fungicide application; and 4) predictive modeling and 5) communication and outreach.

- The monitoring component includes sentinel plots and mobile surveys. Sentinel plots provide quantification of spore production in source regions and mobile surveys provide calibration of predicted model output with disease observations.

- Fewer monitoring resources will be needed in seasons 2006 and 2007. Transition plans should incorporate university and industry cooperators to provide the required monitoring resources. USDA transition plans are covered in a separate document.

Appendix A

State monitoring survey responses

In early January, a questionnaire was sent out to soybean pathologists and State Plant Regulatory Officers. The questionnaire addressed planned monitoring activities for soybean rust in season 2005. Twelve states responded (Table A1).

Table A1. States responses to soybean rust monitoring questionnaire

tate	2004 Soybean	Kudzu	Key Soybean Contact	General Survey			
	acreage (000's)	acreage		Personnel (#)	Start Date	PCR Confirmation (lab/No)	PDA (Y/N)
labama	190	117510	Dr. Edward Sikora, Auburn University, Office 334-844-5502, Cell 334-332-4335	?	?	20 (no lab given)	?
rkansas	3150	10091					
elaware	208	1	Bob Mulrooney, Extension Specialist, Plant Pathology, bobmul@udel.edu	3-4 full time, 3-4 part time	June	USDA in Beltsville	Some PDA
lorida	17	12449	Carrie Lapaire Harmon, Assistant Coordinator, SPDN, University of Florida/IFAS, Department of Plant Pathology, 1450 Fifield Hall or PO Box 110680, Gainesville, FL 32611-0680, Ph: (352) 392-3631 xt 254, Fax: (352) 392-6532, clharmon@ufl.edu	Varies from 1 or 2 to as many as 6-8 at any time	Underway since March 2003	U of FL IFAS Plant Disease Clinic, Dr. Bob McGovern, rjm@mail.ifas.ufl.edu and Mr. Richard Cullen, recullen@mail.ifas.ufl.edu	Some PDA
eorgia	270	151318	Dr. Bob Kemerait extension plant pathologist	?	?	20 (no lab given)	?
inois	9900	529					
diana	5520	98					
owa	10150		Palle Pederson, Extension Agronomist, Iowa State University	?	June 1	If done it will be at Iowa State University	No
ansas	2710	6	Doug Jardine, Extension Soybean Plant Pathologist, Kansas State University, Ph: 785-532-1386, jardine@plantpath.ksu.edu	?	?	?	?
entucky	1300	18051					
ouisiana	990	4824	Clayton A. Hollier, Dept. of Plant Pathology and Crop Physiology, 302 Life Sciences Building, LSU, Baton Rouge, LA 70803.	20	February	APHIS lab at Riverdale	No
aryland	495	134					
ichigan	1980						
innesota	7050						
ississippi	1640	250632					
issouri	4960	1166					

tate	2004 Soybean acreage (000's)	Kudzu acreage	Key Soybean Contact	General Survey			
				Personnel (#)	Start Date	PCR Confirmation (lab/No)	PDA (Y/N)
ebraska	4750	51	Loren Giesler Department of Plant Pathology, University of Nebraska-Lincoln, 406 Plant Science Hall, Lincoln, NE 68583-0722, Ph: (402) 472-2559, lgiesler@unlnotes.unl.edu	15	Late May	Plant and Pest Diagnostic Clinic at the University of Nebraska	Some PDA
ew Jersey	103	9					
ew York	172						
orth arolina	1500	57660					
orth Dakota	3570		Dr. Berlin Nelson - Soybean Pathologist	?	?	?	?
hio	4420	58					
klahoma	290	31					
ennsylvania	425	1					
outh arolina	530	73742					
outh akota	4120						
ennessee	1180	64862	Dr. Melvin Newman, Lead University of Tennessee Plant Specialist, 605 Airways Blvd., Jackson, TN 38301, Ph: 731-425-4718, Email manewman@utk.edu	?	June 1	?	20
exas	270	50817					
irginia	530	11357	David Holshouser, Assoc. Professor & Extension Soybean Specialist. Virginia Tech - Tidewater AREC 6321 Holland Road, Suffolk, VA 23437. Ph: (757) 657-6450 dholshou@vt.edu	50-75	Mid-June through Sept/Oct	University of Florida Lab (NPDN Hub Lab) in Florida and/or the USDA lab in Beltsville, MD	No
/est Virginia	18		Survey accidentally not sent				
/isconsin	1550		Dr. Craig Grau, 482 Russell Laboratories, 1630 Linden Dr, Madison, WI 53706 608-262-6289, 608-262-1410, cg6@plantpath.wisc.edu	?	?	1. DATCP Plant Industry Laboratory, 4702 University Ave., Madison, WI 53705, Anette Phibbs, director, 608-266-7132	?

Put APHIS document in as a reference

Table A1 (continued) State responses to soybean rust monitoring questionaire

State	Sentinel Plots			Additional Industry Resources	Other Comments
	2005 Plots (#)	Geographical Extent	PDA (Y/N)		
Alabama	10-15	Southern tier counties near the coast and areas in the central and northern sections of the state	?	Funding to help monitor sentinel plots, travel for regional extension personnel involved to monitor plots. Travel funds to conduct proper surveys of alternative hosts, funds for hand lenses for growers and agents and for fungicide evaluations	
Arkansas					
Delaware	Yet to be determined	University of Delaware Farm, Georgetown, DE	Some PDA	Spore traps	
Florida	27 variety trials sown in S. Florida- will serve as sentinels plus other soybean trial plots in N. Florida and kudzu trials	Soybean in South and North FL. Kudzu statewide.	Some PDA	Required to handle the enormous pest and disease survey tasks in Florida. Suggested items needed: PDA's, vehicles	
Georgia		Will include most areas where rust was found in Georgia in late 2004		?	Exact survey protocol, # and location of sentinel plots hasn't been finalized
Illinois					
Indiana					
Iowa	May not be required given the high Soybean acreage in Iowa	-	-	Everything from field personnel to lab expenses.	
Kansas	?	?	?	?	
Kentucky					
Louisiana	?	Primarily in coastal parishes in Louisiana and on the LSU AgCenter research stations	No	Travel and field plot maintenance expenses	
Maryland					
Michigan					
Minnesota					
Mississippi					
Missouri					
Nebraska	8	Statewide	Some PDA	Pay for personnel who conduct surveys, for required extensive travel within the state, provide PDA's and data collection training to all personnel	

State	Sentinel Plots			Additional Industry Resources	Other Comments
	2005 Plots (#)	Geographical Extent	PDA (Y/N)		
New Jersey					
New York					
North Carolina					
North Dakota	?	?	?	?	General survey planned- not yet developed. Sentinel sites- Nth central states submitted proposal through Iowa State for plots of early planted soybeans, awaiting funding decision
Ohio					
Oklahoma					
Pennsylvania					
South Carolina					
South Dakota					
Tennessee	30-40	State wide (at least 1 plot/county)	20	Pay for scouting purposes	
Texas					
Virginia	75-100	Major soybean regions of the state, covering approx East 1/3 of Virginia	No	No	
West Virginia					
Wisconsin	Yet to be determined	?	?	?	DATCP is planning field surveys

Appendix B

Animal and Plant Health Inspection Service

Federal/State Responsibility for Identification of *Phakopsora pachyrhizi* December 6, 2004 (Slightly Revised and Reissued February 10, 2005)

Phakopsora pachyrhizi, cause of Asian soybean rust (SBR), was found for the first time in the United States in Louisiana, November 6, 2004. It was subsequently found in additional southeastern states on soybeans as well as kudzu. The disease is likely to spread very rapidly to other soybean-growing areas in the US during the 2005 growing season by means of windborne spores. Therefore, APHIS is not attempting to prevent its spread via a domestic quarantine regulation. State regulatory officials, growers, extension agents, and others are very interested in quick detection of SBR in order to effectively manage the disease. In this regard, APHIS will be allowing States to conduct their own diagnostics as they deem necessary after APHIS confirms the first detection on a host in a State. Permits for importation and interstate movement of *P. pachyrhizi* and *P. meibomiae* are still required, as would be the case for any plant pest.

APHIS has been working closely with stakeholders for several years to prepare for the arrival of SBR. A number of diagnosticians with the National Plant Diagnostic Network and State departments of agriculture have been trained to morphologically identify *P. pachyrhizi* and they have trained first responders. A few scientists have been trained to use real-time PCR to identify *P. pachyrhizi* and differentiate it from the morphologically similar but less aggressive *Phakopsora meibomiae*. The latter species has not been found in the continental US and therefore any *Phakopsora* species on soybean in the US is highly likely to be *P. pachyrhizi*. Ultimately, the soybean grower may not care to know if the soybean rust symptoms are caused by one or both of the *Phakopsora* species. States should decide whether identifications, after the initial PPQ-confirmed state/host records, are based on morphology, or morphology and PCR.

Responsibilities for Identifying *Phakopsora pachyrhizi*

Issue	State	APHIS-PPQ	Outcome
First observation of SBR-like symptoms in a **State**	State sends sample to diagnostic lab. If the lab believes it may be SBR, a sample is sent to PPQ.	PPQ NIS (M. Palm or J. McKemy) examines morphologically. If *Phakopsora*, then a subsample is sent to CPHST (L. Levy) for real-time PCR.	New State record if confirmed positive by PPQ. State enters record into NAPIS.
First observation of SBR-like symptoms on a **host** not previously reported in a State	State sends sample to diagnostic lab. If the lab believes it may be SBR, a sample is sent to PPQ	PPQ NIS (M. Palm or J. McKemy) examines morphologically. If *Phakopsora*, then a subsample is sent to CPHST (L. Levy) for real-time PCR.	New State*Host record if confirmed positive by PPQ. State enters record into NAPIS.
First observation of SBR-like symptoms in a **county** from a State where SBR has already been confirmed by PPQ	State sends sample to diagnostic lab. Identification may be based on morphology, or both morphology and PCR.	N/A. DO NOT SEND TO PPQ	New county record. State enters record into NAPIS.